According to the invention, provided is a photoelectric conversion device using a first conductivity type semiconductor substrate having convex and concave portions formed on its surface, the device being characterized in that it comprises at least, a second conductivity type semiconductor layer formed on the surface of the first conductivity type semiconductor substrate, a front electrode connected to the second conductivity type semiconductor layer, and a rear electrode formed on the rear surface of the first conductivity type semiconductor substrate, the second conductivity type semiconductor layer being in contact with the front electrode at its partial area and becoming thinner as it goes farther from the contacted area.

According to the invention, provided is a method for manufacturing a photoelectric conversion device comprising the steps (a) of forming a film serving as a barrier against impurity diffusion on a semiconductor substrate having convex and concave portions formed on its surface in such a manner that the film becomes thicker from the convex portion to the concave portion, and the steps (b) of implanting second conductivity type impurities into the semiconductor substrate through the film to form a second conductivity type semiconductor layer on the surface of the semiconductor substrate.

According to the invention, provided is a method for manufacturing a photoelectric conversion device comprising the steps (a') of forming a film containing second conductivity type impurities on a semiconductor substrate having convex and concave portions formed on its surface in such a manner that the film becomes thicker from the convex portion to

the concave portion, and steps (b') of implanting second conductivity type impurities into the semiconductor substrate from the film to form a second conductivity type semiconductor layer on the surface of the semiconductor substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view schematically illustrating a photoelectric conversion device of the invention.

Fig. 2 is a cross sectional view schematically illustrating the photoelectric conversion device of Fig. 1.

Fig. 3 is a flow chart showing manufacturing steps of the photoelectric conversion device of Fig. 1.

Fig. 4 is a perspective view schematically illustrating another photoelectric conversion device of the invention.

Fig. 5 is a perspective view schematically illustrating still another photoelectric conversion device of the invention.

Fig. 6 is a perspective view schematically illustrating yet another photoelectric conversion device of the invention.

Fig. 7 is a flow chart showing manufacturing steps of the photoelectric conversion device of Fig. 6.

Fig. 8 is a cross sectional view schematically illustrating a conventional photoelectric conversion device.

Fig. 9 is a perspective view schematically illustrating another conventional photoelectric conversion device.

CLAIMS

1. In a photoelectric conversion device using a first conductivity type semiconductor substrate having convex and concave portions formed on its surface, the device being characterized in that it comprises at least:

a second conductivity type semiconductor layer formed on the surface of the first conductivity type semiconductor substrate;

a front electrode connected to the second conductivity type semiconductor layer; and

a rear electrode formed on the rear surface of the first conductivity type semiconductor substrate,

the second conductivity type semiconductor layer being in contact with the front electrode and becoming thinner as it goes farther from the contacted area.

2. The photoelectric conversion device according to claim 1, wherein the convex portions of the semiconductor substrate are arranged at given intervals and the second conductivity type semiconductor layer becomes thinner from the convex portions to the concave portions of the substrate.

3. The photoelectric conversion device according to claim 2, wherein each convex portion has the front electrode.

4. The photoelectric conversion device according to claim 1, wherein the convex portions of the semiconductor substrate are arranged at given intervals and the second conductivity type semiconductor layer

becomes thicker from the top of the convex portions to the concave portions of the substrate.

5. The photoelectric conversion device according to claim 4, wherein each convex portion has the front electrode.

6. A method for manufacturing a photoelectric conversion device comprising the steps of:

(a) forming a film serving as a barrier against impurity diffusion on a semiconductor substrate having convex and concave portions formed on its surface in such a manner that the film becomes thicker from the convex portion to the concave portion; and

(b) implanting second conductivity type impurities into the semiconductor substrate through the film to form a second conductivity type semiconductor layer on the surface of the semiconductor substrate.

7. The method according to claim 6, further comprising the step of:

(c) forming a front electrode which contact the convex portion of the semiconductor substrate surface.

8. A method for manufacturing a photoelectric conversion device comprising the steps of:

(a) forming a film containing second conductivity type impurities on a semiconductor substrate having convex and concave portions formed on its surface in such a manner that the film becomes thicker from the convex portion to the concave portion; and

(b) implanting second conductivity type impurities into the semiconductor substrate from the film to form a second conductivity type

semiconductor layer on the surface of the semiconductor substrate.

9. The method according to claim 8, further comprising the step of:

(c) forming a front electrode which contact the concave portion of the semiconductor substrate surface.